

Deep Space Atomic Clock (DSAC)

Completed Technology Project (2011 - 2021)



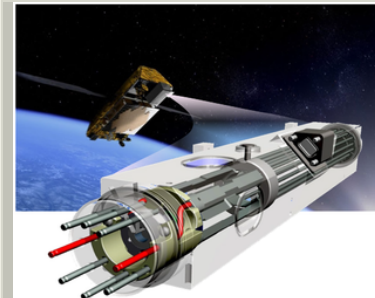
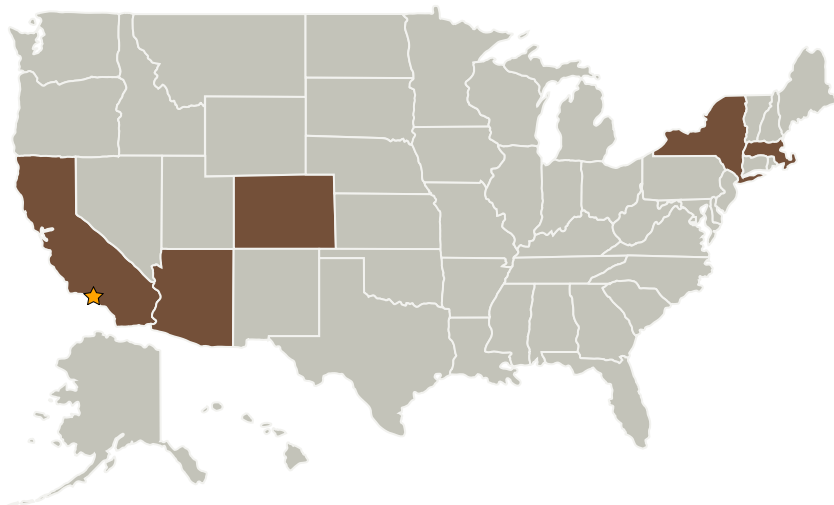
Project Introduction

The Deep Space Atomic Clock (DSAC) project will develop a small, low mass atomic clock based on mercury-ion trap technology and demonstrate it in space providing the time keeping stability needed for the next-generation of deep space navigation and radio science. The mercury-ion clock coupled with an ultra-stable oscillator and a Global Positioning Satellite (GPS) receiver will launch as a hosted payload on the Surrey Orbital Test Bed (OTB) mission. While in orbit, the DSAC payload will make use of GPS signals to perform precision orbit determination and confirm the clock's performance. After the demonstration, future missions to both Earth orbit and deep space will be able to use the results of the DSAC demonstration to develop customized versions of DSAC for operational purposes. This demonstration will advance the TRL of the mercury-ion atomic clock from the laboratory (TRL5) to an advanced prototype flown in space (TRL7) resulting in sufficient data and experience to develop the engineering roadmap to an eventual operational version for space missions.

Anticipated Benefits

DSAC enables a shift to a more flexible/extensible 1-Way radionavigation architecture from the current 2-Way model. Program is a fundamental to autonomous radionavigation, and will increase navigation and radio science tracking data accuracy by 10 times and quantity by 2 times. DSAC has the potential to improve clock performance of the next GPS system by 50x.

Primary U.S. Work Locations and Key Partners



Artist rendition of the Deep Space Atomic Clock. The Deep Space Atomic Clock project will fly and validate a miniaturized, ultra-precise, mercury-ion atomic clock that is orders of magnitude more stable than today's best navigation clocks,...

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Organizations Performing Work	Role	Type	Location
★ Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California
Air Force Space and Missile Systems Center	Supporting Organization	US Government	Kirtland AFB, New Mexico
FEI Technologies, Inc.	Supporting Organization	Industry	
General Atomics	Supporting Organization	Industry	
Microsemi Corporation	Supporting Organization	Industry	
Moog, Inc(MOOG)	Supporting Organization	Industry	East Aurora, New York
University of Colorado Boulder Laboratory for Atmospheric and Space Physics(LASP)	Supporting Organization	Academia	Boulder, Colorado

Co-Funding Partners	Type	Location
Space Communications and Navigation(SCaN)	NASA Program	

Primary U.S. Work Locations	
Arizona	California
Colorado	Massachusetts
New York	

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Technology Demonstration Missions

Project Management

Program Director:

Trudy F Kortes

Program Manager:

Tawnya P Laughinghouse

Principal Investigator:

Todd A Ely

Co-Investigators:

John D Prestage

Robert L Tjoelker

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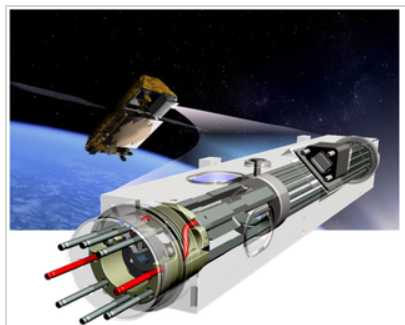


Images

**4882-1349058387359.jpg**

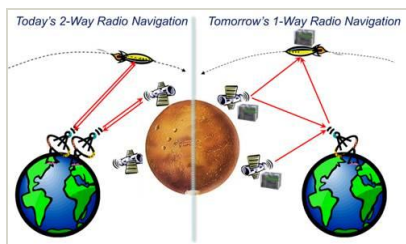
Project Image Deep Space Atomic Clock (DSAC)

(https://techport.nasa.gov/image/100857)

**Deep Space Atomic Clock (DSAC).png**

Artist rendition of the Deep Space Atomic Clock. The Deep Space Atomic Clock project will fly and validate a miniaturized, ultra-precise, mercury-ion atomic clock that is orders of magnitude more stable than today's best navigation clocks, forever changing the way we conduct deep-space navigation. The DSAC project, managed for NASA's Space Technology Mission Directorate by NASA's Jet Propulsion Laboratory, is building a demonstration unit and payload for launch to Earth orbit in 2017, at which time the payload will be operated for at least a year to demonstrate its functionality and utility for one-way-based navigation.

(https://techport.nasa.gov/image/100863)

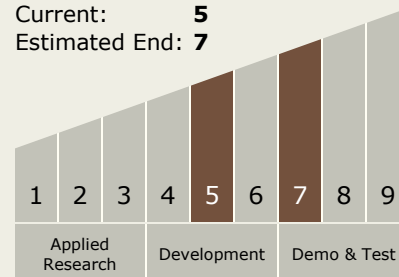
**DSAC Image_3**

DSAC

(https://techport.nasa.gov/image/100855)

Technology Maturity (TRL)

Start: 5
Current: 5
Estimated End: 7



Technology Areas

Primary:

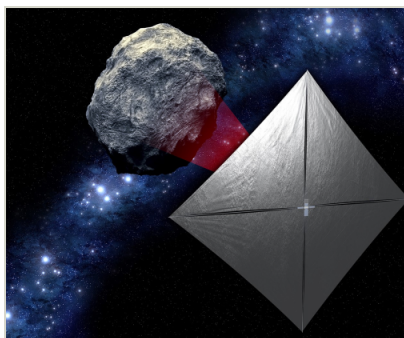
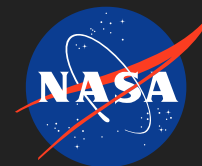
- TX05 Communications, Navigation, and Orbital Debris Tracking and Characterization Systems
 - └ TX05.4 Network Provided Position, Navigation, and Timing
 - └ TX05.4.1 Timekeeping and Time Distribution

Target Destinations

The Moon, Mars, Foundational Knowledge

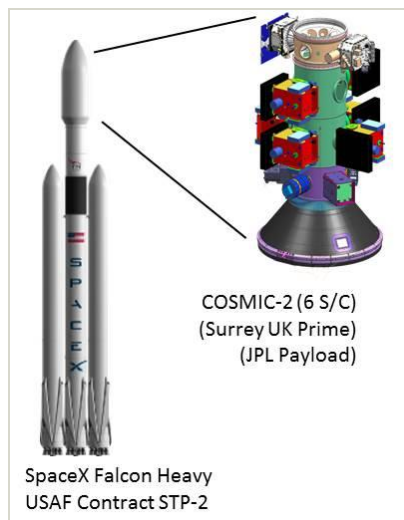
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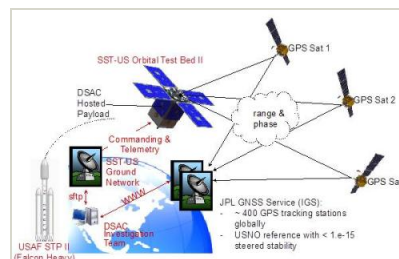
DSAC Image_3

DSAC
(<https://techport.nasa.gov/image/100856>)



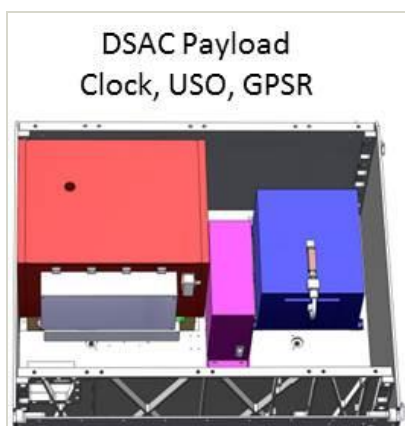
DSAC Image_4

DSAC Image_4
(<https://techport.nasa.gov/image/100858>)



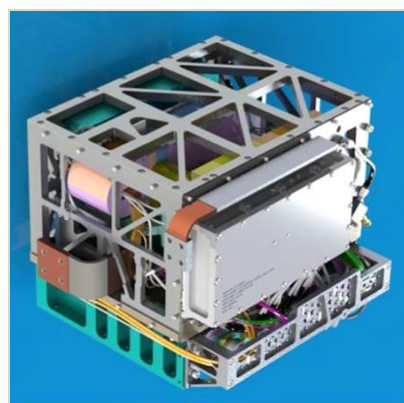
DSAC Mission Architecture

DSAC Mission Architecture
(<https://techport.nasa.gov/image/100862>)



DSAC Payload Clock, USO, GPSR

DSAC Payload Clock, USO, GPSR
(<https://techport.nasa.gov/image/100860>)



DSAC Preliminary Configuration of the Demonstration Unit

DSAC
(<https://techport.nasa.gov/image/100861>)



Surrey OTB Based on SSTL-150 Bus

Surrey OTB Based on SSTL-150 Bus
(<https://techport.nasa.gov/image/100859>)

Links

Deep Space Atomic Clock Moves Toward Increased Spacecraft Autonomy
(<https://www.jpl.nasa.gov/news/deep-space-atomic-clock-moves-toward-increased-spacecraft-autonomy>)

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Demonstration of a trapped-ion atomic clock in space
(<https://www.nature.com/articles/s41586-021-03571-7>)

Project Website:

https://www.nasa.gov/mission_pages/tdm/main/index.html#.VQb6XUjJzyE